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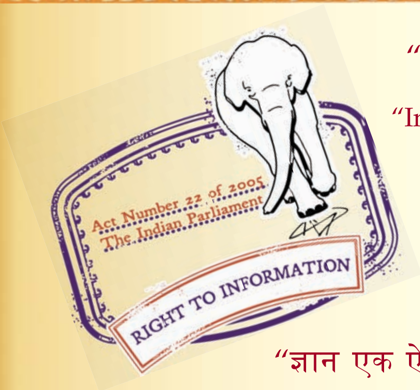

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METHODS OF MEASUREMENT FOR MAGNETIC TAPES FOR VIDEO RECORDING AND REPRODUCTION

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Gr 4 *January* 1984

Indian Standard

METHODS OF MEASUREMENT FOR MAGNETIC TAPES FOR VIDEO RECORDING AND REPRODUCTION

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METHODS OF MEASUREMENT FOR MAGNETIC TAPES FOR VIDEO RECORDING AND REPRODUCTION

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 September 1983, after the draft finalized by the Recording Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard covers the methods of measurement for evaluation of the properties of magnetic tapes for video recording and reproduction.

0.3 While preparing this standard, assistance has been derived from IEC Doc: 60 B (C.O.) 44 'Draft — Measuring methods for video tape properties', issued by the International Electrotechnical Commission.

0.4 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard describes the methods of measurement for determining the physical, mechanical and electrical performance characteristics of magnetic tapes for video recording and reproduction.

2. TERMINOLOGY

2.1 For the purpose of this standard, the terms and definitions given in IS : 1885 (Part 48/Sec 1)-1978† shall apply.

3. CONDITIONS FOR MEASUREMENTS

3.1 All properties, if not otherwise specified, shall be measured at a temperature of 25 ± 1°C, in a humidity of 48 percent to 52 percent and an atmospheric pressure between 86 kPa and 106 kPa. The test sample to

*Rules for rounding off numerical values (*revised*).
†Electrotechnical vocabulary: Part 48 Recording, Section 1 Tape recording.

be measured has to be stored for 24 hours at the above conditions to assure correct testing results. This is defined as the standard environment for this document.

4. TESTS FOR MECHANICAL CHARACTERISTICS

4.1 Tape Width — The tape, covered with a glass, shall be measured without tension at a minimum of five different positions along the tape using a calibrated microscope or profile projector having an accuracy of at least 1/400 mm = 2·5 μm. The average of the five readings gives the tape width.

4.2 Tape Thickness — The tape thickness shall be obtained by placing ten sections of tape from the sample on top of each other in a suitable manner, measuring with a micrometer gauge and dividing the reading by ten.

4.3 Tensile Tests

4.3.1 The measurements shall be made in accordance with Appendix A. The length of the test sample shall be 200 mm. The rate of elongation for all tensile tests shall be 100 mm/min ± 10 percent.

4.3.2 *Breaking Strength* — The sample shall be loaded until the breaking point of the sample is reached. The force at that point gives the breaking strength of the tape.

4.3.3 *Yield Strength* (*F* 5%) — The yield strength (F 5%) is the force necessary to produce five percent elongation of the tape.

4.4 Residual Elongation

4.4.1 To measure the residual elongation a test sample approximately 1 m long shall be subjected to a tension of 50 N/mm^2 over the total cross section for a period of 3 minutes.

4.4.2 The sample shall then be measured with negligible force (0·25 N) three minutes after the load has been removed.

4.4.3 The residual elongation is given as a percentage of the original tape length.

4.5 Longitudinal Shrinkage

4.5.1 A test sample (approximately 1 metre long) shall be stored in the standard environment for 48 hours. It shall then be vertically suspended and loaded with 0·25 N force. The length of the test sample, three minutes after the load has been applied, gives the original tape length.

4.5.2 The environment shall then be changed to 50°C and 13 percent relative humidity for a period of 18 hours. Three hours after restoring the

standard environment the shrinkage of the sample shall be measured and expressed as a percentage of the original tape length.

4.6 Coefficient of Elongation in Humidity

4.6.1 A test sample (approximately one metre long) shall be stored in the standard environment for 48 hours. It shall then be vertically suspended and loaded with 0·25 N force. The length of the test sample, three minutes after the load has been applied, gives the original tape length.

4.6.2 After increasing the relative humidity by 30 percent for a period of 18 hours the elongation shall be measured and expressed as a percentage of the original tape length.

4.7 Transverse Cupping

4.7.1 Transverse cupping of the tape is generally the result of contractions of the coated dispersion during drying. It may also be due to a differential absorption of moisture by base and coating. It takes the form of a concavity on the coated side. Cupping leads to poor winding properties of the tape and tends to impose unequal strains over the tape width. It is also impossible to ensure the essential intimate contact between the tape and head all over the tape width when pronounced cupping is present without subjecting the tape to undesirable tension during use.

4.7.2 *Test Procedure* — The tape samples are exposed for a duration of 12 hours each:

a) first at a temperature between 38°C and 42°C and humidity of less than 15 percent,

b) and then, at a temperature between 38°C and 42°C and relative humidity between 90 and 100 percent.

At the end of the period of exposure the cupping shall be measured with goniometer or any other suitable instrument.

4.7.3 A tape sample 10 mm in length shall be placed, concave side down, on a smooth flat surface. Transverse cupping is the maximum departure of the tape sample from the flat surface. The time between cutting the tape and the measurement shall be at least one hour.

4.7.4 The tape sample and the test surface shall not be charged electrostatically.

4.8 Longitudinal Curvature

4.8.1 *Static Longitudinal Curvature* — A tape sample one metre long shall be allowed to unroll and assume its natural curvature on a flat surface.

The maximum deviation of the edge of the tape from a straight line joining the extremities of the tape sample is the static longitudinal curvature.

4.8.2 *Dynamic Measurement of Longitudinal Curvature* — The test sample shall be measured in a test arrangement according to Fig. 1A and 1B. The variation of the tape edge shall be measured with a light sensor through a slot of 1 mm width, in the area of the lower tape edge. The output signal is proportional to the variations of the tape edge. The variation of each edge shall be measured and the worst value shall be reported.

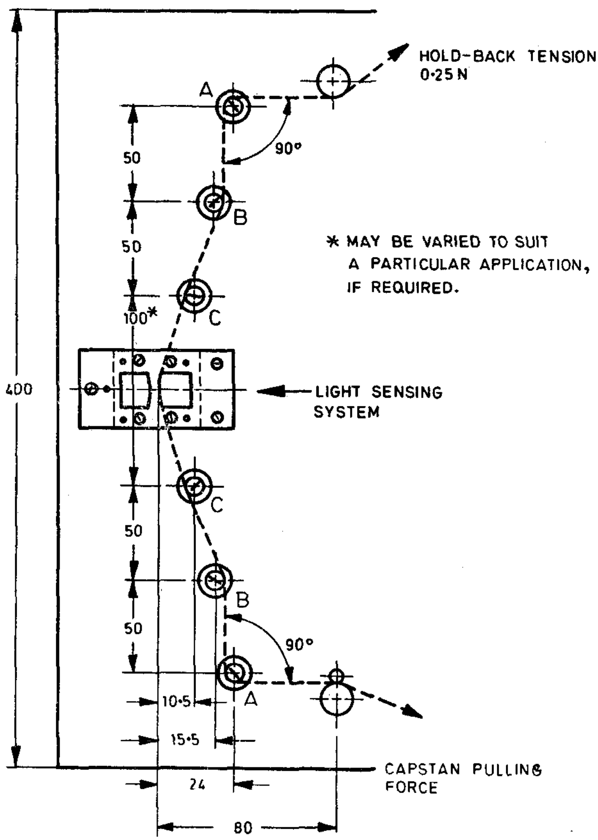

FIG. 1A TEST SYSTEM FOR DYNAMIC MEASUREMENT OF LONGITUDINAL CURVATURE

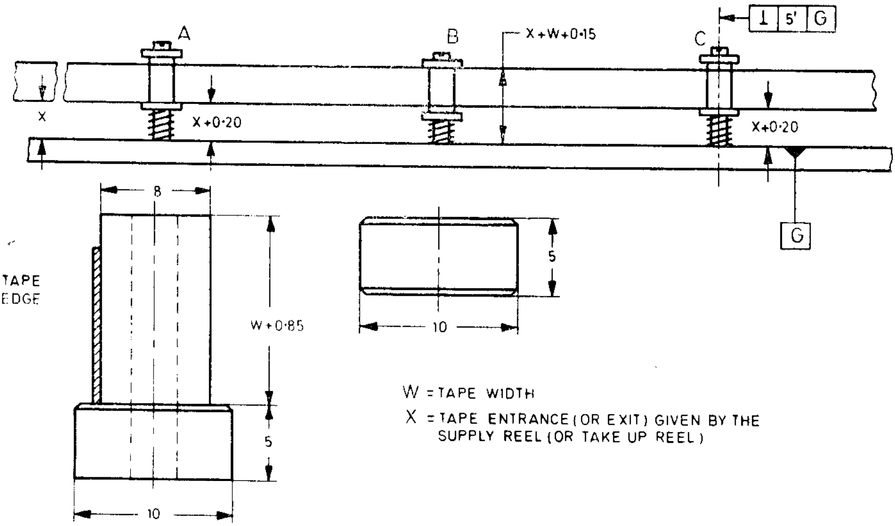

FIG. 1B TEST SYSTEM FOR DYNAMIC MEASUREMENT OF LONGITUDINAL CURVATURE

4.9 Coefficient of Friction

4.9.1 *Quasi-static Friction of the Coating Side*

4.9.1.1 The test drum shall be a steel cylinder as shown in Fig. 2 having a diameter 100 mm and a surface roughness Ra = 0·25 μm in accordance with IS : 3073-1967*. For particular applications a drum of different material and different surface roughness may be used. The drum shall be cleaned with tetrahydrofuran before starting the test.

4.9.1.2 *Procedure* — The test sample with its coating side facing the test drum shall be pulled over the drum for 2 minutes at a velocity of 5 cm/min. After a short pause the procedure can be started under the same conditions and registered.

$$\text{Coefficient of friction } \mu = \frac{1}{\alpha} \quad l_n \frac{F_1}{F_2}$$

where

α = angle of wrap around the drum (π) in radians.
F_1 = 0·5 N load, and
F_2 = F_1 + friction

(Values of velocity and load are chosen for practical reasons).

*Assessment of surface roughness.

4.9.2 *Quasi-static Friction of the Reverse Side*

4.9.2.1 The drum shall be replaced by a steel pin of 8 mm diameter and a surface roughness Ra = 0·07 μm (*see* Fig. 2). For special applications a pin of different material and different surface roughness may be used. The test procedure shall be as in **4.9.1** except that the reverse side of the tape is facing the pin surface.

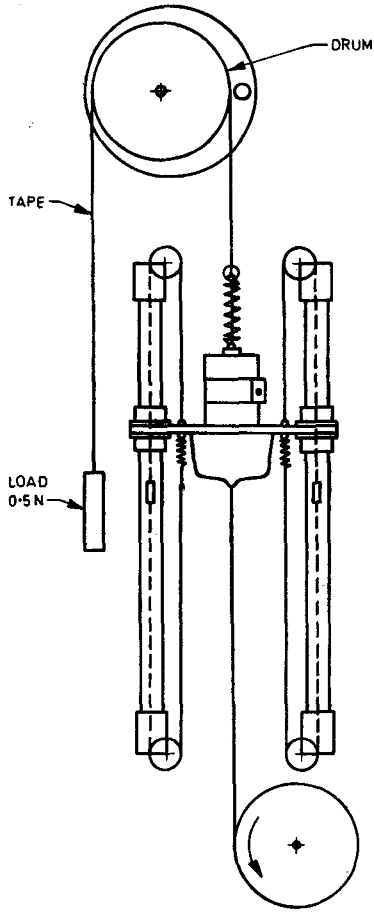

FIG. 2 TEST SYSTEM FOR MEASUREMENT OF QUASI FRICTION

4.9.3 *Dynamic Friction of the Coating Side*

4.9.3.1 The dynamic friction shall be measured with the equipment shown in Fig. 3. This machine is capable of varying the speed in the range from 0·5 cm/s to about 20 cm/s. For the material of the drum and the pin, *see* **4.9.1** and **4.9.2**.

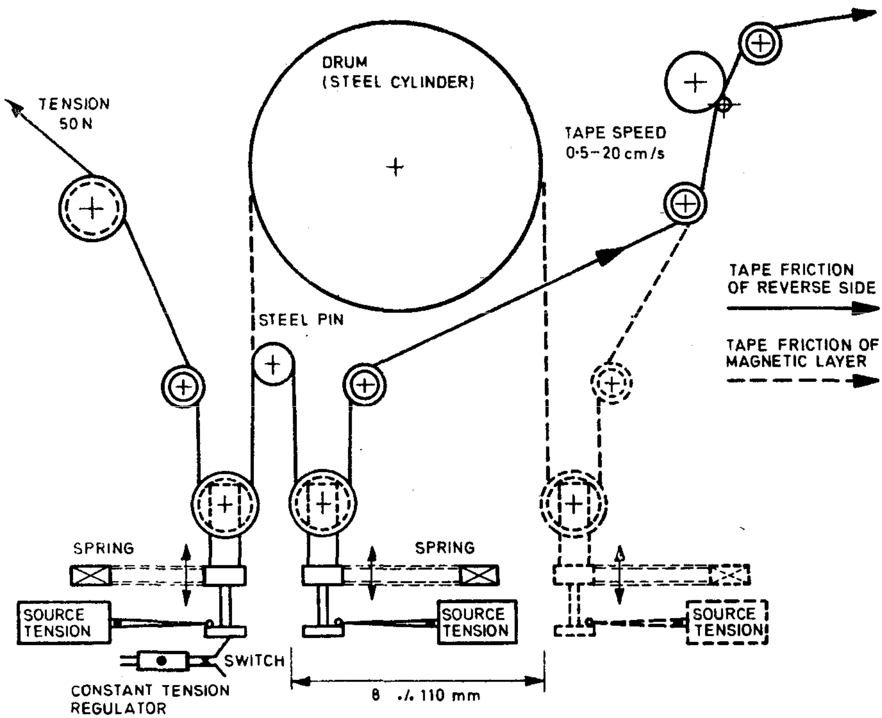

Fig. 3 Test System for Dynamic Measurement of Friction

4.9.3.2 When a tape is run from 0·5 cm/s to approximately 20 cm/s the maximum value of μ and the speed at which the maximum value is obtained shall be noted.

4.9.3.3 From the diagram of friction versus speed, the coefficient of friction shall be calculated at two speed values, namely at the speed at which F_2 has its maximum and at a specified speed characteristic for the recording equipment.

4.9.3.4 The frictional characteristics can be expressed by the values:

a) The maximum value of friction and the corresponding speed, and

b) At a certain speed to be specified.

4.9.4 *Dynamic Friction of Reverse Side*

4.9.4.1 For measurement on the reverse side, the test procedure shall be same as in **4.9.3** except that the reverse side is facing the pin.

4.10 Layer-to-Layer Adhesion

4.10.1 A tape one metre in length shall be wound on a glass tube of 36 mm diameter at a tension of 50 N/mm^2 with one end of the tape fixed to the glass tube.

4.10.2 The wound test piece shall be kept at a temperature of 45 $\pm$ 3°C and relative humidity of 80 percent for 4 hours, and afterwards in the standard environment for 24 hours.

4.10.3 For some special applications requiring more stringent test conditions, the tape sample is wound on a 22·7 mm diameter tube of non-oxidizing material and exposed to a temperature/relative humidity condition of 54°C and 84 percent relative humidity for 16 hours and afterwards under the standard environment for 24 hours.

4.10.4 Finally, the test piece shall be unwound slowly with a 0·1 N load at the end. Then any tendency for tape sticking and delamination of the magnetic coating shall be observed.

4.11 Video Head Wear

4.11.1 Tape tension, head mounting, tip protrusion and all other machine parameters shall be controlled in accordance with the specification of the recorder used.

4.11.2 Before starting the test, one roll of the tape type to be tested in run for 5 hours on a new head for the purpose of contouring. Another roll of the same tape type shall be run for 100 passes of at least 45 minutes per pass and the decrease of head protrusion shall be measured by means of a suitable instrument. The decrease of head protrusion is a measure of head wear. The playing time of the test sample shall be stated.

5. TESTS FOR ELECTROMAGNETIC AND ELECTRICAL CHARACTERISTICS

5.1 Coercivity (H_c) and Retentivity (B_r)

5.1.1 Coercivity and retentivity shall be measured by using a dynamic $B - H$ versus H hysteresis loop tracer. The frequency and the field strength used shall be stated.

5.2 Coating Resistance

5.2.1 Two electrodes shall be set apart corresponding to sample width as shown in Fig. 4. The cross section of each electrode shall be a quarter of a circle of radius 1 cm.

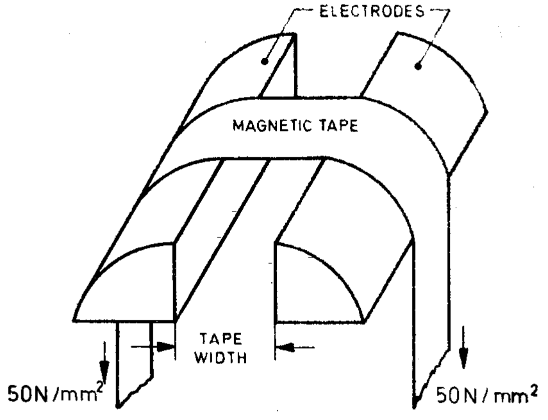

FIG. 4 TEST SET UP FOR COATING RESISTANCE

5.2.2 The test sample shall be placed across the electrodes, with the longitudinal direction of the tape perpendicular to the electrodes and with the magnetic coating of the tape in contact with the electrodes.

5.2.3 Next, two weights producing a tension of 5 N/mm² shall be suspended one at each end of the test sample. Then the electrical resistance between the electrodes shall be measured by a suitable instrument. The coating resistance is defined as that electrical resistance.

5.3 TESTS FOR VIDEO CHARACTERISTICS

5.3.0 The type of machine used shall be stated. It shall be set up in accordance with specification of the manufacturers instruction manual.

5.3.1 *Writing Current for Maximum RF Output* — During recording of a 100 percent white level video signal the writing current is varied. After switching over to playback, the RF output representing the 100 percent white level is measured in the FM channel, ahead of any AGC or limiting. The writing current giving the maximum output is the writing current for maximum RF output.

5.3.2 *RF Output-Luminance* — The RF output is the maximum RF level obtained at the writing current described in **5.3.1**.

5.3.3 *RF Output-Chrominance* — Under consideration.

5.3.4 *Video Signal-to-Noise Ratio* — Under consideration.

5.3.5 *Frequency Response in the FM Channel* — Frequency response is the ratio expressed in dB of the playback output level resulting from the frequency corresponding to the synchronizing pulse tip and the output at the frequency corresponding to the white level.

5.3.6 *Chrome Noise* — Under consideration.

5.3.7 *Drop-Out*

5.3.7.1 A recording is made in accordance with **5.3.1**.

5.3.7.2 A drop-out is a momentary random signal reduction in the amplitude of the RF signal recovered from the tape. With the use of electronic drop-out counting equipment, the number and summarised time of drop-outs during each 1 minute are recorded.

5.3.7.3 The drop-out to be counted is any defect which creates a specified loss expressed in dB in the unlimited RF playback level for a specified time expressed in microseconds. The values used for depth and width shall be stated as well as the head tip height.

5.3.8 *Signal Wear*

5.3.8.1 A recording is made in accordance with **5.3.1**. The unlimited RF output is measured on playback during the first and the fiftieth pass. The playing time for each pass shall be at least 5 minutes. The change of RF output expressed in dB is a measure of signal wear.

5.3.9 *Tape Life*

5.3.9.1 Two identical video tape recorders shall be used for this test. Tape tensions head mounting, tip protrusion and all other machine parameters shall be controlled in accordance with the machine manufacturer's specifications.

5.3.9.2 Using VTR A, the tape to be tested shall be recorded over at least a 10 minute section with a signal according to **5.3.1**. This section is then replayed, the drop-out rate counted and the performance assessed.

5.3.9.3 Using VTR B, the recorded section shall be then replayed for 100 passes.

5.3.9.4 The procedure in **5.3.9.2** shall be repeated over exactly the same section of tape, that is the tape shall be recorded and its replay performance assessed.

This is followed by a repetition of procedure in **5.3.9.3**.

This process shall be continued, counting the total number of passes, until it is found that the tape under test no longer meets the performance requirements of the recorder system used to conduct the test. At this point the test shall be terminated.

The total number of passes taken to reach this point is a measure of the usable tape life.

5.3.10 *Still Frame (Stop Motion)* — One frame of a video track is scanned in stop mode until there is an obvious breakdown of the reproduced signal. The time taken to reach this point is a measure of stop motion capability of the tape.

5.4 Tests for Audio Characteristics

5.4.0 Provisions of **5.3.0** in addition to the following shall apply.

5.4.0.1 All references to frequency f_1 are either 315 Hz or 1 000 Hz depending on the method and all references to frequency f_2 are either 7 kHz or 10 kHz depending on the method used. The bias current at which the following test is conducted shall be adjusted according to one of the following procedures at a level 15-20 dB below saturation (*see* Fig. 5):

a) The audio bias current shall be given by $(a + c)/2$, where 'a' and 'c' are the bias current values at which the playback output at 315 Hz is 1 dB below the maximum obtainable playback output.

b) The audio bias current shall be given by $(a + c)/2$, where 'a' and 'c' are the bias current values at which the playback output at 1 000 Hz is 1 dB below the maximum obtainable playback output.

c) When a signal of 1 kHz is recorded, the bias current should be that which gives a playback level 1 dB less than the maximum output; the measured current being greater than that which gives maximum output from the tape (that is point c in Fig. 5).

The method used shall be stated.

5.4.1 *Audio Sensitivity* — The playback output level obtained from the test sample on which a signal of frequency f_1 is recorded at a level 15-20 dB below saturation shall be measured. Audio sensitivity is the ratio, expressed in dB, of the playback output level of a signal at a frequency f_1 from the test sample to that of another tape, used as a reference recorded under the same conditions.

5.4.2 *Output Uniformity* — In the measurement of output variation, a signal of a frequency f_1 shall be recorded over the entire length of the test sample under the same conditions as in the measurement of the audio sensitivity.

The output uniformity is the ratio in *dB* of the highest to the lowest playback output level measured over the entire length of tape.

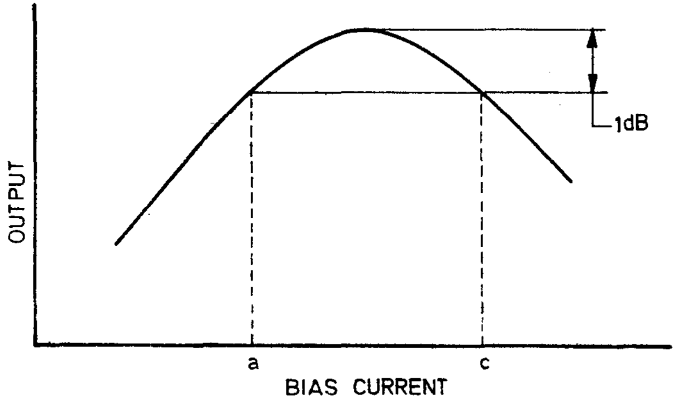

FIG. 5 BIAS CURRENT ADJUSTMENT

5.4.3 *Audio Frequency Response* — A signal of frequency f_1 and another signal of frequency f_2 shall be recorded on the test sample at the same input voltage which is equivalent to the playback output 20 dB below the saturation level at the frequency f_1 of the tape. Next, the playback output level at the frequencies f_1 and f_2 shall be measured. The same procedure shall be repeated for the tape used as a reference.

Audio frequency response difference between the two tapes is expressed by D, where $D = d - d_0$.

d = (output in dB at f_2 — output in dB at f_1) for tape under test, and

d_0 = (output in dB at f_2 — output in dB at f_1) for tape used as a reference.

5.4.4 *Erasability*

5.4.4.1 A signal of frequency f_1 shall be recorded on the test sample on a VTR which is in accordance with the machine manufacturer's specification. A portion of the above mentioned recording shall be erased.

The erasability is the ratio in dB of the playback output level of the non-erased portion to the residual playback output level of the erased portion.

Both measurements shall be made using a suitable selective deviee.

APPENDIX A

(*Clause* 4.3.1)

DETERMINATION OF TENSILE PROPERTIES

A-1. GENERAL

A-1.1 The tensile properties that can be measured by the procedures described in this method include tensile stress at break and elongation at the yield point.

A-2. APPARATUS

A-2.1 Testing Machine — Testing machine with grips that can be separated at the rate specified.

A-2.1.1 *Grips* — Grips for holding the test specimen, one being attached to a fixed or essentially stationary member of the machine and the other to a movable member. The grips are self-aligning; that is, they are attached to the fixed and movable member respectively in such a manner that they will move freely into alignment as soon as any load is applied, so that the long axis of the test specimen will coincide with the direction of the applied pull through the centre line of the grip assembly. The test specimen is held in such a way that slip relative to the grips is prevented as far as possible. The grips may conveniently be of the kind that tighten automatically under load.

A-2.1.2 *Load Indicator* — Suitable load-indicating mechanism capable of showing the total tensile load carried by the test specimen when held by the grips. This mechanism is essentially free from inertia lag at the specified rate of testing and indicates the load with an accuracy of $\pm$ 1 percent of the indicated value, or better.

A-2.2 Extension Indicator (When Required) — Suitable instrument for determining, at any time during the test the distance between two fixed points or reference lines located within the middle parallel-sided part of the test specimen. It is desirable, but not essential, that this instrument should automatically record this distance (or any change in it) as a function of the load on the test specimen or of the elapsed time from the start of the test, or both. If only distance as a function of elapsed time is recorded, load-time data are also taken. The instrument is essentially free of inertia lag at the specified speed of testing and is accurate to $\pm$ 1 percent of strain or better. For the measurement of modulus of elasticity the instrument is capable of measuring the distance between the reference lines to an accuracy of $\pm$ 0·1 mm.

A-2.3 Micrometers — Screw micrometer reading to at least 0·02 mm for measuring the width and thickness of test specimens.

Dial-gauge micrometer, reading to at least 0·02 mm and provided with a flat circular foot that will apply a pressure of 0·01 to 0·03 N/mm^2 to the test specimen, for measuring the thickness of test specimens of non-rigid materials.

A-3. NUMBER OF TESTS

A-3.1 At least five test specimens are tested for each sample.

A-3.2 Test specimens that do not break within the parallel position are discarded and further specimens are tested.

A-4. SPEED OF MACHINE

A-4.1 The speed of testing is the rate of separation of the grips of the testing machine during the test. The speed shall be 100 mm/min —10 percent.

A-5. PROCEDURE

A-5.1 The thickness of test specimen is measured at several points to the nearest 1 percent with the dial-gauge micrometer described in **A-2.3**. The width is taken to be the width measured to the nearest 0·05 mm of the middle parallel-sided part.

A-5.2 The test specimen is placed in the grips of the testing machine taking care to align the long axis of the test specimen and the grips with an imaginary line joining the points of attachment of the grips to the machine. The grips are tightened evenly and firmly to the degree necessary to prevent the test specimen from slipping during the test but not to the point where the specimen would be crushed.

A-5.3 The extension indicator is attached.

A-5.4 The speed is set at the specified value and the machine is started.

A-5.5 The loads and corresponding deformation are rewarded at appropriate and approximately even intervals of strain in the region of elastic behaviours.

A-6. CALCULATION AND EXPRESSION OF RESULTS

A-6.1 Tensile Stress at Break — The load in kilogrammes-force at break is divided by the original minimum cross-sectional area of the test specimen in square centimetre. The result shall be expressed in N/mm^2 and reported to three significant figures.

A-6.2 Percentage Elongation at Yield — The extension at the yield point is divided by the original distance between the reference lines and multiplied by 100. The percentage elongation at yield is reported to two significant figures.